General

Guideline Title

Intravenous fluid therapy in children and young people in hospital.

Bibliographic Source(s)

National Clinical Guideline Centre. Intravenous fluid therapy in children and young people in hospital. London (UK): National Institute for Health and Care Excellence (NICE); 2015 Dec 9. 33 p. (NICE guideline; no. 29).

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

The wording used in the recommendations in this guideline (for example, words such as 'offer' and 'consider') denotes the certainty with which the recommendation is made (the strength of the recommendation) and is defined at the end of the "Major Recommendations" field.

Principles and Protocols for Intravenous Fluid Therapy

For guidance on the principles and protocols for intravenous (IV) fluid therapy, see the "Principles and Protocols for Intravenous Fluid Therapy" section in the NGC summary of the NICE guideline Intravenous fluid therapy in adults in hospital (the first 8 recommendations in this section apply to all ages).

Offer IV fluid therapy as part of a protocol (see algorithms for IV fluid therapy in children and young people in hospital in the original guideline document):

- Assess fluid and electrolyte needs following algorithm 1: Assessment and monitoring.
- If term neonates, children and young people need IV fluids for fluid resuscitation, follow algorithm 2: Fluid resuscitation.
- If term neonates, children and young people need IV fluids for routine maintenance, follow algorithm 3: Routine maintenance.
- If term neonates, children and young people need IV fluids to address existing deficits or excesses, ongoing abnormal losses or abnormal

fluid distribution, follow algorithm 4: Replacement and redistribution.
- If hypernatraemia develops, follow algorithm 5: Managing hypernatraemia that develops during IV fluid therapy.
- If hyponatraemia develops, follow algorithm 6: Managing hyponatraemia that develops during IV fluid therapy.

Assessment and Monitoring

Use body weight to calculate IV fluid and electrolyte needs for term neonates, children and young people.

Consider using body surface area to calculate IV fluid and electrolyte needs if accurate calculation of insensible losses is important (for example, if the weight is above the 91st centile, or with acute kidney injury, known chronic kidney disease or cancer).

In term neonates, children and young people who are receiving IV fluids, assess and document the following:

- Actual or estimated daily body weight. Record the weight from the current day, the previous day, and the difference between the two. If an estimate was used, the actual weight should be measured as soon as clinically possible.
- Fluid input, output and balance over the previous 24 hours
- Any special instructions for prescribing, including relevant history
- An assessment of the fluid status
- The results of laboratory and point-of-care assessments, including:
    - Full blood count
    - Urea
    - Creatinine
    - Plasma electrolyte concentrations (including chloride, sodium and potassium; see recommendation below)
    - Blood glucose (see recommendation below)
    - Urinary electrolyte concentrations
- Details of any ongoing losses (see recommendation below and the diagram of ongoing losses in the original guideline document)
- Calculations of fluid needs for routine maintenance, replacement, redistribution and resuscitation
- The fluid and electrolyte prescription (in ml per hour), with clear signatures, dates and times
- Types and volumes of fluid input and output (urine, gastric and other), recorded hourly and with running totals
- 12-hourly fluid balance subtotals
- 24-hourly fluid balance totals
- 12-hourly reassessments of:
    - The fluid prescription
    - Current hydration status
    - Whether oral fluids can be started
    - Urine and other outputs

Measure plasma electrolyte concentrations using laboratory tests when starting IV fluids, and then at least every 24 hours or more frequently if there are electrolyte disturbances.

Measure blood glucose when starting IV fluids, and then at least every 24 hours or more frequently if there is a risk of hypoglycaemia.

Consider point-of-care testing for measuring plasma electrolyte concentrations and blood glucose in time-critical situations when IV fluids are needed (for example, during emergency situations and in the accident and emergency department [A&E], theatre and critical care).

Diagnose clinical dehydration and hypovolaemic shock using the clinical features listed in table 1 in the original guideline document, but be aware that it can be difficult to identify the clinical features in term neonates.

Fluid Resuscitation

If children and young people need IV fluid resuscitation, use glucose-free crystalloids[1] that contain sodium in the range 131–154 mmol/litre, with a bolus of 20 ml/kg over less than 10 minutes. Take into account pre-existing conditions (for example, cardiac disease or kidney disease), as smaller fluid volumes may be needed.

If term neonates need IV fluid resuscitation, use glucose-free crystalloids[1] that contain sodium in the range 131–154 mmol/litre, with a bolus of 10–20 ml/kg over less than 10 minutes.

Do not use tetrastarch for fluid resuscitation.

For guidance on using IV fluids for fluid resuscitation in children and young people with diabetic ketoacidosis, see the "Diabetic Ketoacidosis" section in the NGC summary of the NICE guideline Diabetes (type 1 and type 2) in children and young people: diagnosis and management.

Reassess term neonates, children and young people after completion of the IV fluid bolus, and decide whether they need more fluids.

Seek expert advice (for example, from the paediatric intensive care team) if 40–60 ml/kg of IV fluid or more is needed as part of the initial fluid resuscitation.

Routine Maintenance

Calculate routine maintenance IV fluid rates for children and young people using the Holliday–Segar formula (100 ml/kg/day for the first 10 kg of weight, 50 ml/kg/day for the next 10 kg and 20 ml/kg/day for the weight over 20 kg). Be aware that over a 24-hour period, males rarely need more than 2500 ml and females rarely need more than 2000 ml of fluids.

Calculate routine maintenance IV fluid rates for term neonates according to their age, using the following as a guide:

- From birth to day 1: 50–60 ml/kg/day
- Day 2: 70–80 ml/kg/day
- Day 3: 80–100 ml/kg/day
- Day 4: 100–120 ml/kg/day
- Days 5–28: 120–150 ml/kg/day

If children and young people need IV fluids for routine maintenance, initially use isotonic crystalloids[2] that contain sodium in the range 131–154 mmol/litre.

Measure plasma electrolyte concentrations and blood glucose when starting IV fluids for routine maintenance (except before most elective surgery), and at least every 24 hours thereafter.

Be aware that plasma electrolyte concentrations and blood glucose are not routinely measured before elective surgery unless there is a need to do so, based on the child's medical condition or the type of surgery.

Base any subsequent IV fluid prescriptions on the plasma electrolyte concentrations and blood glucose measurements.

If term neonates need IV fluids for routine maintenance, initially use isotonic crystalloids[2] that contain sodium in the range 131–154 mmol/litre with 5% to 10% glucose.

For term neonates in critical postnatal adaptation phase (for example, term neonates with respiratory distress syndrome, meconium aspiration, hypoxic ischaemic encephalopathy), give no or minimal sodium until postnatal diuresis with weight loss occurs.

If there is a risk of water retention associated with non-osmotic antidiuretic hormone (ADH) secretion, consider either:

- Restricting fluids to 50% to 80% of routine maintenance needs or
- Reducing fluids, calculated on the basis of insensible losses within the range 300–400 ml/m^2/24 hours plus urinary output

When using body surface area to calculate IV fluid needs for routine maintenance (see recommendation in the "Assessment and Monitoring" section above), estimate insensible losses within the orange 300–400 ml/m^2/24 hours plus urinary output.

Replacement and Redistribution

If term neonates, children and young people need IV fluids for replacement or redistribution, adjust the IV fluid prescription (in addition to maintenance needs) to account for existing fluid and/or electrolyte deficits or excesses, ongoing losses (see the diagram of ongoing losses in the original guideline document) or abnormal distribution, for example, tissue oedema seen in sepsis.

Consider isotonic crystalloids[2] that contain sodium in the range 131–154 mmol/litre for redistribution.

Use 0.9% sodium chloride containing potassium to replace ongoing losses (see the diagram of ongoing losses in the original guideline document).

Base any subsequent fluid prescriptions on the plasma electrolyte concentrations and blood glucose measurements.

Managing Hypernatraemia That Develops During Intravenous Fluid Therapy

If hypernatraemia develops in term neonates, children and young people, review the fluid status and take action as follows:

- If there is no evidence of dehydration and an isotonic fluid is being used, consider changing to a hypotonic fluid (for example, 0.45% sodium chloride with glucose)[3].
- If dehydration is diagnosed, calculate the water deficit and replace it over 48 hours, initially with 0.9% sodium chloride.
- If the fluid status is uncertain, measure urine sodium and osmolality.
- If hypernatraemia worsens or is unchanged after replacing the deficit, review the fluid type and consider changing to a hypotonic solution (for example, 0.45% sodium chloride with glucose).

When correcting hypernatraemia, ensure that the rate of fall of plasma sodium does not exceed 12 mmol/litre in a 24-hour period.

Measure plasma electrolyte concentrations every 4 to 6 hours for the first 24 hours, and after this base the frequency of further plasma electrolyte measurements on the treatment response.

Managing Hyponatraemia That Develops during Intravenous Fluid Therapy

If asymptomatic hyponatraemia develops in term neonates, children and young people, review the fluid status and take action as follows:

- If a child is prescribed a hypotonic fluid, change to an isotonic fluid (for example, 0.9% sodium chloride).
- Restrict maintenance IV fluids in children and young people who are hypervolaemic or at risk of hypervolaemia (for example, if there is a risk of increased ADH secretion) by either:
    - Restricting maintenance fluids to 50% to 80% of routine maintenance needs or
    - Reducing fluids, calculated on the basis of insensible losses within the range 300–400 ml/m^2/24 hours plus urinary output

Be aware that the following symptoms are associated with acute hyponatraemia during IV fluid therapy:

- Headache
- Nausea and vomiting
- Confusion and disorientation
- Irritability
- Lethargy
- Reduced consciousness
- Convulsions
- Coma
- Apnoea

If acute symptomatic hyponatraemia develops in term neonates, children and young people, review the fluid status, seek immediate expert advice (for example, from the paediatric intensive care team) and consider taking action as follows:

- Use a bolus of 2 ml/kg (maximum 100 ml) of 2.7% sodium chloride over 10 to 15 minutes.
- Use a further bolus of 2 ml/kg (maximum 100 ml) of 2.7% sodium chloride over the next 10 to 15 minutes if symptoms are still present after the initial bolus.
- If symptoms are still present after the second bolus, check the plasma sodium level and consider a third bolus of 2 ml/kg (maximum 100 ml) of 2.7% sodium chloride over 10 to 15 minutes.
- Measure the plasma sodium concentration at least hourly.
- As symptoms resolve, decrease the frequency of plasma sodium measurements based on the response to treatment.

Do not manage acute hyponatraemic encephalopathy using fluid restriction alone.

After hyponatraemia symptoms have resolved, ensure that the rate of increase of plasma sodium does not exceed 12 mmol/litre in a 24-hour period.

Training and Education

For guidance on training and education for healthcare professionals involved in prescribing and delivering IV fluid therapy, see the "Training and Education" section in the NGC summary of the NICE guideline Intravenous fluid therapy in adults in hospital.

Footnotes

[1]At the time of publication (December 2015), some glucose-free crystalloids did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

[2]At the time of publication (December 2015), some isotonic crystalloids with 5–10% glucose did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

[3]At the time of publication (December 2015), some hypotonic solutions did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

Definitions

Strength of Recommendations

Some recommendations can be made with more certainty than others. The Guideline Development Group (GDG) makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the GDG is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

Interventions That Must (or Must Not) Be Used

The GDG usually uses 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally the GDG uses 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

Interventions That Should (or Should Not) Be Used – a 'Strong' Recommendation

The GDG uses 'offer' (and similar words such as 'refer' or 'advise') when confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. The GDG uses similar forms of words (for example, 'Do not offer…') when confident that an intervention will not be of benefit for most patients.

Interventions That Could Be Used

The GDG uses 'consider' when confident that an intervention will do more good than harm for most patients, and be cost effective, but other options may be similarly cost effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

Clinical Algorithm(s)

The following algorithms for intravenous (IV) fluid therapy in children and young people in hospital are provided in the original guideline document:

- Algorithm 1: Assessment and monitoring
- Algorithm 2: Fluid resuscitation
- Algorithm 3: Routine maintenance
- Algorithm 4: Replacement and redistribution
- Algorithm 5: Managing hypernatraemia (plasma sodium more than 145 mmol/litre) that develops during IV fluid therapy
- Algorithm 6: Managing hyponatraemia (plasma sodium less than 135 mmol/litre) that develops during IV fluid therapy

In addition, a National Institute for Health and Care Excellence (NICE) pathway titled "Intravenous fluid therapy in hospital overview" in provided on the NICE Web site.

Scope

Disease/Condition(s)

Conditions requiring intravenous (IV) fluid administration

Guideline Category

Evaluation

Management

Prevention

Treatment

Clinical Specialty

Critical Care

Emergency Medicine

Nursing

Pediatrics

Intended Users

Advanced Practice Nurses

Hospitals

Nurses

Physician Assistants

Physicians

Guideline Objective(s)

- To provide recommendations on the assessment, monitoring and reassessment of fluid and electrolyte status; intravenous (IV) fluid therapy for resuscitation, maintenance and replacement and redistribution; management of hyponatraemia and hypernatraemia that develops during IV fluid administration and the skills needed for adequate training and education of healthcare professionals
- To help prescribers understand the:
    - Indications for IV fluid therapy
    - Reasons for the choice of the various fluids available
    - Prevention and treatment of sodium imbalance
    - Principles of assessing fluid balance
    - Training and education needs of those prescribing IV fluids

Target Population

Neonates born at term, infants, children and young people up to their 16th birthday receiving intravenous (IV) fluids in hospital (babies born prematurely with a corrected age of term or more were also included)

Note: The guideline does not provide recommendations for adults aged 16 years or older and babies born prematurely whose corrected age is less than term.

Interventions and Practices Considered

1. Methods of assessing intravenous (IV) fluid requirements
2. Methods of calculating IV fluid requirements
    - Measurement and documentation
    - Laboratory-based methods versus point-of-care testing
    - Assessing dehydration and hypovolaemia
3. IV fluid therapy for fluid resuscitation
    - Fluid type
    - Volume and rate of administration
4. IV fluid therapy for routine maintenance
    - Fluid type
    - Rate of administration
5. IV fluid therapy for replacement and redistribution
6. Managing hypernatraemia and hyponatraemia that develops during IV fluid administration
7. Training and education of healthcare professional for management of IV fluid therapy

Major Outcomes Considered

- Adverse effects (including hypovolaemia, dehydration, hypervolaemia, neurological complications, hypoglycaemia, hypernatraemia, hyponatraemia)
- Fluid balance
- Quality of life
- Mortality
- Length of hospital stay
- Test turnaround time
- Neurological compromise (return to baseline activity, ischaemic injury, cerebral oedema)
- Cardiovascular compromise (blood pressure [BP]/arterial pressure, heart rate)
- Hyperchloraemic acidosis
- Cost-effectiveness

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

Developing the Review Questions and Outcomes

Review questions were developed in a PICO framework (patient, intervention, comparison and outcome) for intervention reviews. This was to guide the literature searching process and to facilitate the development of recommendations by the Guideline Development Group (GDG).

This use of a framework guided the literature searching process, critical appraisal and synthesis of evidence, and facilitated the development of recommendations by the GDG. The review questions were drafted by the NCGC technical team and refined and validated by the GDG. The questions were based on the key clinical areas identified in the scope (see Appendix A). The GDG considered the relative importance of these and prioritised areas for developing review questions. This decision to prioritise certain areas took into consideration factors such as whether the area is a key clinical issue for the National Health Service (NHS), patient safety, cost (to the NHS), equality and variations in practice.

A total of 12 review questions were identified.

Full literature searches, critical appraisals and evidence reviews were completed for all the specified review questions.

Searching for Evidence

Clinical Literature Search

Systematic literature searches were undertaken to identify all published clinical evidence relevant to the review questions. Searches were undertaken according to the parameters stipulated within The guidelines manual 2012 (see the "Availability of Companion Documents" field). Databases were searched using relevant medical subject headings, free-text terms and study-type filters where appropriate. Studies published in languages other than English were not reviewed. Where possible, searches were restricted to articles published in English. All searches were conducted in MEDLINE, EMBASE, and The Cochrane Library. Additional subject specific databases were used for some questions: PsycINFO and CINAHL for the training and education question. All searches were updated on 22 December 22 2014. No papers published after this date were considered.

Search strategies were quality assured by cross-checking reference lists of highly relevant papers, analysing search strategies in other systematic reviews, and asking GDG members to highlight any additional studies. The questions, the study types applied, the databases searched and the years covered can be found in Appendix F.

The titles and abstracts of records retrieved by the searches were sifted for relevance, with potentially significant publications obtained in full text. These were assessed against the inclusion criteria.

During the scoping stage, a search was conducted for guidelines and reports on the Web sites listed below from organisations relevant to the topic. Searching for unpublished literature was not undertaken. All references sent by stakeholders were considered.

- Guidelines International Network database (www.g-i-n.net)
- National Guideline Clearinghouse (www.guideline.gov)
- NICE (www.nice.org.uk)
- National Institutes of Health Consensus Development Program (consensus.nih.gov)
- NHS Evidence Search (www.evidence.nhs.uk)

Health Economic Literature Search

Systematic literature searches were also undertaken to identify health economic evidence within published literature relevant to the review questions. The evidence was identified by conducting a broad search relating to IV fluid therapy for children in the NHS Economic Evaluation Database (NHS EED), the Health Economic Evaluations Database (HEED) and Health Technology Assessment (HTA) databases with no date restrictions. Additionally, the search was run on MEDLINE and EMBASE, with a specific economic filter, from 2011, to ensure recent publications that had not yet been indexed by these databases were identified. Studies published in languages other than English were not reviewed. Where possible, searches were restricted to articles published in English language.

The search strategies for health economics are included in Appendix F. All searches were updated on 22 December 2014. No papers published after this date were considered.

Evidence of Effectiveness

The evidence was reviewed following the steps shown schematically in Figure 1 in the full guideline:

- Potentially relevant studies were identified for each review question from the relevant search results by reviewing titles and abstracts. Full papers were then obtained.
- Full papers were reviewed against pre-specified inclusion and exclusion criteria to identify studies that addressed the review question in the

appropriate population (review protocols are included in Appendix C).

Inclusion and Exclusion Criteria

The inclusion and exclusion of studies was based on the review protocols, which can be found in Appendix C . Excluded studies by review question (with the reasons for their exclusion) are listed in Appendix K. The GDG was consulted about any uncertainty regarding inclusion or exclusion.

The guideline population was neonates born at term, infants, children and young people up to their 16th birthday receiving intravenous (IV) fluids in hospital. Babies born prematurely with a corrected age of term or more were also included.

The GDG considered applicability of the population for each clinical question according to the clinical context of the review question. In areas where evidence was anticipated to be lacking the GDG considered evidence from indirect populations and settings which were directly applicable to the clinical question. Some examples are the inclusion of studies of dengue fever or malaria for management of sepsis.

Systematic reviews, including Cochrane reviews appropriately matching protocol and randomised trials meeting the guideline condition, were preferentially included in the clinical review. Cochrane reviews meeting the PICO were quality assessed and presented. Any papers included in the Cochrane that were not reviewed in the original guideline and deemed to be important were ordered and considered for inclusion. In the absence of randomised control trial (RCT) evidence, non-randomised trials and observational studies within the guideline population were included. The GDG only considered prospective or retrospective cohort studies of at least 50 children to be of sufficient quality on which to base recommendations.

The GDG agreed to consider RCTs in a population of adults only for questions in which the clinical evidence could be appropriately extrapolated to the guideline population. For example, adult evidence, in the absence of studies in children, could be applied to fluid type questions (routine maintenance and resuscitation), but not rate of fluid administration.

Conference abstracts were not automatically excluded from the review but were initially assessed against the inclusion criteria and then further processed only if no other full publication was available for that review question, in which case the authors of the selected abstracts would be contacted for further information. However, no clinical reviews presented with appropriate conference abstract data.

Laboratory studies (including human, animal or in vitro) were excluded as these settings were considered to be artificial and not comparable to the guideline population. Literature reviews, posters, letters, editorials, comment articles, unpublished studies and studies not in English were excluded.

The review protocols are presented in Appendix C.

Evidence of Cost-effectiveness

The GDG is required to make decisions based on the best available evidence of both clinical and cost effectiveness. Guideline recommendations should be based on the expected costs of the different options in relation to their expected health benefits (that is, their 'cost-effectiveness') rather than the total implementation cost. Thus, if the evidence suggests that a strategy provides significant health benefits at an acceptable cost per patient treated, it should be recommended even if it would be expensive to implement across the whole population.

Evidence on cost-effectiveness related to the key clinical issues being addressed in the guideline was sought. The health economist:

- Undertook a systematic review of the published economic literature
- Undertook new economic analysis in priority areas

Literature Review

The health economist:

- Identified potentially relevant studies for each review question from the economic search results by reviewing titles and abstracts. Full papers were then obtained.
- Reviewed full papers against prespecified inclusion and exclusion criteria to identify relevant studies

Inclusion and Exclusion Criteria

Full economic evaluations (studies comparing costs and health consequences of alternative courses of action: cost–utility, cost-effectiveness, cost–benefit and cost–consequences analyses) and comparative costing studies that addressed the review question in the relevant population were considered potentially includable as economic evidence.

Studies that only reported cost per hospital (not per patient), or only reported average cost effectiveness without disaggregated costs and effects, were excluded. Literature reviews, abstracts, posters, letters, editorials, comment articles, unpublished studies and studies not in English were excluded.

Remaining studies were prioritised for inclusion based on their relative applicability to the development of this guideline and the study limitations. For example, if a high quality, directly applicable United Kingdom (UK) analysis was available, then other less relevant studies may not have been included. Where exclusions occurred on this basis, this is noted in the relevant section.

For more details about the assessment of applicability and methodological quality see the economic evaluation checklist (Appendix F of The guidelines manual and the health economics review protocol in Appendix C of the full guideline appendices).

When no relevant economic studies were found from the economic literature review, relevant UK NHS unit costs related to the compared interventions were presented to the GDG to inform the possible economic implications of the recommendations.

Number of Source Documents

Refer to the article selection reviews in the full guideline appendices (Appendix D for clinical articles and Appendix E for economic articles [see the "Availability of Companion Documents" field]) for flow charts and detailed information on the total number of studies identified, selected, and excluded for each guideline topic.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Overall Quality of Outcome Evidence in Grading of Recommendations Assessment, Development and Evaluation (GRADE)

Level	Description
High	Further research is very unlikely to change confidence in the estimate of effect.
Moderate	Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.
Low	Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.
Very low	Any estimate of effect is very uncertain.

Methods Used to Analyze the Evidence

Meta-Analysis

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

Evidence of Effectiveness

The evidence was reviewed following the steps shown schematically in Figure 1 in the full version of the guideline:

- Relevant studies were critically appraised using the appropriate checklist as specified in The guidelines manual (see the "Availability of Companion Documents" field).
- Key information was extracted on the study's methods, PICO (patient, intervention, comparison and outcome) factors and results. These were presented in summary tables (in each review chapter) and evidence tables (in Appendix G).
- Summaries of evidence were generated by outcome (included in the relevant review chapters) and were presented in Guideline Development Group (GDG) meetings:
    - Randomised studies: data were meta-analysed where appropriate and reported in Grading of Recommendations Assessment, Development, and Evaluation (GRADE) profiles (for intervention reviews).
    - Observational studies: data were presented as a range of values in GRADE profiles.
    - Qualitative studies: each study was summarised in a table where possible, otherwise presented in a narrative.

  A 20% sample of each of the above stages of the reviewing process was quality assured by a second reviewer to eliminate any potential of reviewer bias or error.

Methods of Combining Clinical Studies

Data Synthesis for Intervention Reviews

Where possible, meta-analyses were conducted to combine the results of studies for each review question using Cochrane Review Manager (RevMan5) software. Fixed-effects (Mantel-Haenszel) techniques were used to calculate risk ratios (relative risk) for the binary outcomes, such as mortality and neurological sequelae. Hazard ratios will be presented wherever possible for outcomes that are time dependent, that is, mortality.

For continuous outcomes, measures of central tendency (mean) and variation (standard deviation) were required for meta-analysis. Data for continuous outcomes, such as intensive care unit (ICU) length of stay, were analysed using an inverse variance method for pooling weighted mean differences. When the only evidence was based on studies that summarised results by presenting medians (and interquartile ranges), or only p values were given, this information was assessed in terms of the study's sample size and was included in the Grading of Recommendations Assessment, Development and Evaluation (GRADE) tables without calculating the relative or absolute effects (that is, ICU length of stay in the replacement and redistribution clinical review). Consequently, aspects of quality assessment such as imprecision of effect could not be assessed for evidence of this type.

Stratified analyses were predefined for some review questions at the protocol stage when the GDG identified that these strata are different in terms of biological and clinical characteristics and the interventions were expected to have a different effect on subpopulations. For example, for questions regarding resuscitation the protocol was stratified by patients undergoing resuscitation for trauma, surgery or sepsis. Additionally, other questions considering direct administration of fluid were stratified by population age (for example for Review question 7, the following age strata were chosen: 0–48 hours, 48 hours–28 days, 28 days–16 years).

Data were recorded and presented by the authors. In the case in which there is missing data with a difference >10% between the groups, and the study has an impact on the conclusion (that is, a large study) the GDG will conduct an available case analysis and compare it to what the authors reported (intention-to-treat [ITT]) in a sensitivity analysis.

Statistical heterogeneity was assessed by visually examining the forest plots, and by considering the chi-squared test for significance at $p<0.1$ or an I-squared inconsistency statistic (with an I-squared value of more than 50% indicating considerable heterogeneity). Where considerable heterogeneity was present, the GDG carried out predefined subgroup analyses. Sensitivity analysis based on the quality of studies was also carried out, eliminating studies at overall high or very high risk of bias (randomisation, allocation concealment and blinding, missing outcome data).

Assessments of potential differences in effect between subgroups were based on the chi-squared tests for heterogeneity statistics between subgroups. If no sensitivity analysis was found to completely resolve statistical heterogeneity, then a random-effects (DerSimonian and Laird) model was employed to provide a more conservative estimate of the effect.

The means and standard deviations of continuous outcomes were required for meta-analysis. Where p values were reported as 'less than', a conservative approach was undertaken. For example, if the p value was reported as '$p\leq0.001$', the calculations for standard deviations will be based on a p value of 0.001. If these statistical measures were not available then the methods described in Section 16.1.3 of the Cochrane Handbook (March 2011) 'Missing standard deviations' were applied as the last resort.

For interpretation of the binary outcome results, differences in the absolute event rate were calculated using the GRADEpro software for the median event rate across the control arms of the individual studies in the meta-analysis. Absolute risk differences were presented in the GRADE profiles and in clinical summary of findings tables, for discussion with the GDG.

Data Synthesis for Qualitative Study Reviews

Where possible, a meta-synthesis would be conducted to combine qualitative study results. The main aim of the synthesis of qualitative data is a description of the main topics that may influence the experience of care of the child, rather than to build new theories or reconceptualise the topic under review. Only one review question (Review question 12, on training and education of healthcare professionals) was identified as being qualitative, and no studies were found from searches that met the inclusion criteria. Therefore, a qualitative review was not conducted.

Appraising the Quality of Evidence by Outcomes

The evidence for outcomes from the included RCTs and observational studies were evaluated and presented using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international GRADE working group (http://www.gradeworkinggroup.org). The software developed by the GRADE working group (GRADEpro) was used to assess the quality of each outcome, taking into account individual study quality factors and the meta-analysis results. Results were presented in GRADE profiles ('GRADE tables'), which consist of 2 sections: the 'Clinical evidence profile' table includes details of the quality assessment while the 'Clinical evidence summary of findings' table includes pooled outcome data (where appropriate), an absolute measure of intervention effect and the summary of quality of evidence for that outcome. In this table, the columns for intervention and control indicate summary measures and measures of dispersion (such as mean and standard deviation or median and range) for continuous outcomes and frequency of events (n: the sum across studies of the number of patients with events divided by sum of the number of completers) for binary outcomes. Reporting or publication bias was only taken into consideration in the quality assessment and included in the 'Clinical evidence profile' table if it was apparent.

The evidence for each outcome was examined separately for the quality elements listed and defined in Table 1 in the full version of the guideline. Each element was graded using the quality levels listed in Table 2 in the full version of the guideline. The main criteria considered in the rating of these elements are discussed in the full version of the guideline. Standardised footnotes were used to describe reasons for grading a quality element as having serious or very serious problems. The ratings for each component were summed to obtain an overall assessment for each outcome (see the "Rating Scheme for the Strength of the Evidence" field).

Grading the Quality of Clinical Evidence

After results were pooled, the overall quality of evidence for each outcome was considered. The following procedure was adopted when using GRADE:

1. A quality rating was assigned, based on the study design. RCTs start as High, observational studies as Low.
2. The rating was then downgraded for the specified criteria: risk of bias (study limitations), inconsistency, indirectness, imprecision and publication bias. These criteria are detailed in Sections 3.3 of the full version of the guideline. Evidence from observational studies (which had not previously been downgraded) was upgraded if there was: a large magnitude of effect, a dose–response gradient, and if all plausible confounding would reduce a demonstrated effect or suggest a spurious effect when results showed no effect. Each quality element considered to have 'serious' or 'very serious' risk of bias was rated down by 1 or 2 points respectively.
3. The downgraded or upgraded marks were then summed and the overall quality rating was revised. For example, all RCTs started as High and the overall quality became Moderate, Low or Very low if 1, 2 or 3 points were deducted respectively.
4. The reasons or criteria used for downgrading were specified in the footnotes.

The details of the criteria used for each of the main quality element are discussed further in Sections 3.3.2.6 to 3.3.2.7 of the full version of the guideline.

Evidence Statements

Evidence statements are summary statements that are presented after the GRADE profiles, summarising the key features of the clinical effectiveness evidence presented. The wording of the evidence statements reflects the certainty or uncertainty in the estimate of effect.

The evidence statements are presented by outcome and encompass the following key features of the evidence:

- The number of studies and the number of participants for a particular outcome
- A brief description of the participants
- An indication of the direction of effect (if one treatment is beneficial or harmful compared to the other, or whether there is no difference between the 2 tested treatments)
- A description of the overall quality of evidence (GRADE overall quality)

Evidence of Cost-effectiveness

The GDG is required to make decisions based on the best available evidence of both clinical and cost-effectiveness. Guideline recommendations should be based on the expected costs of the different options in relation to their expected health benefits (that is, their 'cost-effectiveness') rather than the total implementation cost. Thus, if the evidence suggests that a strategy provides significant health benefits at an acceptable cost per patient treated, it should be recommended even if it would be expensive to implement across the whole population.

Evidence on cost effectiveness related to the key clinical issues being addressed in the guideline was sought. The health economist:

- Undertook a systematic review of the published economic literature
- Undertook new economic analysis in priority areas

Undertaking New Health Economic Analysis

As well as reviewing the published economic literature for each review question, new economic analysis was undertaken by the health economist in selected areas. Priority areas for new health economic analysis were agreed by the GDG after formation of the review questions and consideration of the available health economic evidence.

The GDG identified clinical assessment and reassessment as the highest priority area for original economic modelling. The monitoring of fluid balance in children could include the measurement and recording of weight as well as the recording of fluid balance (including input and output) on a fluid balance chart. Well performed and recorded monitoring is important as this may prevent the occurrence of fluid-related complications. Monitoring should be performed at regular intervals and at an optimum frequency since this information may tailor intervention. However, excessive monitoring may increase costs unnecessarily and may provide little additional health benefit. A cost and threshold analysis was thus undertaken to inform recommendations regarding the optimal monitoring strategy.

The following general principles were adhered to in developing the cost-effectiveness analysis:

- Methods were consistent with the NICE reference case.
- The GDG was involved in the design of the model, selection of inputs and interpretation of the results.
- Model inputs were based on the systematic review of the clinical literature supplemented with other published data sources where possible.
- When published data were not available, GDG expert opinion was used to populate the model.
- Model inputs and assumptions were reported fully and transparently.
- The results were subject to sensitivity analysis and limitations were discussed.
- The model was peer-reviewed by another health economist at the NCGC.

Full methods for the cost and threshold analysis for monitoring strategies are described in Appendix M.

Cost-effectiveness Criteria

NICE's report 'Social value judgements: principles for the development of NICE guidance' sets out the principles that GDGs should consider when judging whether an intervention offers good value for money. In general, an intervention was considered to be cost effective if either of the following criteria applied (given that the estimate was considered plausible):

- The intervention dominated other relevant strategies (that is, it was both less costly in terms of resource use and more clinically effective compared with all the other relevant alternative strategies), or
- The intervention cost less than £20,000 per quality-adjusted life-year (QALY) gained compared with the next best strategy

If the GDG recommended an intervention that was estimated to cost more than £20,000 per QALY gained, or did not recommend one that was estimated to cost less than £20,000 per QALY gained, the reasons for this decision are discussed explicitly in the 'Recommendations and link to evidence' section of the relevant chapter of the full version of the guideline, with reference to issues regarding the plausibility of the estimate or to the factors set out in 'Social value judgements: principles for the development of NICE guidance'.

In the Absence of Economic Evidence

When no relevant published studies were found, and a new analysis was not prioritised, the GDG made a qualitative judgement about cost effectiveness by considering expected differences in resource use between options and relevant UK National Health Service (NHS) unit costs, alongside the results of the clinical review of effectiveness evidence.

The UK NHS costs reported in the guideline are those that were presented to the GDG and were correct at the time recommendations were drafted. They may have changed subsequently before the time of publication. However, the GDG has no reason to believe they have changed substantially.

Methods Used to Formulate the Recommendations

Expert Consensus

Informal Consensus

Description of Methods Used to Formulate the Recommendations

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

Who Developed This Guideline?

A multidisciplinary Guideline Development Group (GDG) comprising health professionals and researchers as well as lay members developed this guideline. The group met approximately every 6 weeks during the development of the guideline.

Staff from the NCGC provided methodological support and guidance for the development process. The team working on the guideline included a project manager, systematic reviewers, health economists and information scientists. They undertook systematic searches of the literature, appraised the evidence, conducted meta-analysis and cost-effectiveness analysis where appropriate and drafted the guideline in collaboration with the GDG.

Developing Recommendations

Over the course of the guideline development process, the GDG was presented with:

- Evidence tables of the clinical and economic evidence reviewed from the literature. All evidence tables are in Appendices G and H.
- Summaries of clinical and economic evidence and quality (as presented in Chapters 5–10 in the full version of the guideline)
- Forest plots (see Appendix J)
- A description of the methods and results of the cost (and threshold) analysis undertaken for the guideline (see Appendix M)

Recommendations were drafted on the basis of the GDG's interpretation of the available evidence, taking into account the balance of benefits, harms and costs between different courses of action. This was either done formally in an economic model, or informally. Firstly, the net benefit over harm (clinical effectiveness) was considered, focusing on the critical outcomes. When this was done informally, the GDG took into account the clinical benefits and harms when one intervention was compared with another. The assessment of net benefit was moderated by the importance placed on the outcomes (the GDG's values and preferences), and the confidence the GDG had in the evidence (evidence quality). Secondly, whether the net benefit justified any differences in costs was assessed.

When clinical and economic evidence was of poor quality, conflicting or absent, the GDG drafted recommendations based on their expert opinion. The considerations for making consensus-based recommendations include the balance between potential harms and benefits, the economic costs compared to the economic benefits, current practices, recommendations made in other relevant guidelines, patient preferences and equality issues. The consensus recommendations were agreed through discussions in the GDG. The GDG also considered whether the uncertainty was sufficient to justify delaying making a recommendation to await further research, taking into account the potential harm of failing to make a clear recommendation.

The GDG considered the 'strength' of recommendations. This takes into account the quality of the evidence but is conceptually different. Some recommendations are 'strong' in that the GDG believes that the vast majority of healthcare and other professionals and patients would choose a particular intervention if they considered the evidence in the same way that the GDG has. This is generally the case if the benefits clearly outweigh the harms for most people and the intervention is likely to be cost effective. However, there is often a closer balance between benefits and harms, and some patients would not choose an intervention whereas others would. This may happen, for example, if some patients are particularly averse to some side effect and others are not. In these circumstances the recommendation is generally weaker, although it may be possible to make stronger recommendations about specific groups of patients.

The GDG focused on the following factors in agreeing the wording of the recommendations:

- The actions health professionals need to take
- The information readers need to know
- The strength of the recommendation (for example the word 'offer' was used for strong recommendations and 'consider' for weak

recommendations)
- The involvement of patients (and their carers if needed) in decisions on treatment and care
- Consistency with NICE's standard advice on recommendations about drugs, waiting times and ineffective interventions

The main considerations specific to each recommendation are outlined in the 'Recommendations and link to evidence' sections within each chapter in the full version of the guideline.

Recommendations Based on Consensus

The GDG acknowledged that it was unlikely to be possible to undertake clinical evidence reviews for certain areas of the guideline due to the lack of evidence. Areas which were exceptions to the normal systematic review process included:

- Body surface area versus body weight (Review question 1)
- Key components to be measured and documented on an intravenous (IV) fluid balance and/or prescription chart (Review question 2)
- Assessment of dehydration and hypovolaemia (Review question 4)
- Volume and rate of resuscitation fluid (Review question 6)
- Treatment of hypernatraemia (Review question 10)
- Treatment of hyponatraemia (Review question 11)

The GDG therefore chose to take into consideration their own clinical experience, principles of physiology and pathophysiology of IV fluids and other accepted standard clinical guidance and drafted recommendations based on formal consensus in a format intended to be useful to a clinician. The discussion is documented in the 'Linking evidence to recommendations' section in each chapter in the full version of the guideline.

Rating Scheme for the Strength of the Recommendations

Strength of Recommendations

Some recommendations can be made with more certainty than others. The Guideline Development Group (GDG) makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the GDG is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

Interventions That Must (or Must Not) Be Used

The GDG usually uses 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally the GDG uses 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

Interventions That Should (or Should Not) Be Used – a 'Strong' Recommendation

The GDG uses 'offer' (and similar words such as 'refer' or 'advise') when confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. The GDG uses similar forms of words (for example, 'Do not offer…') when confident that an intervention will not be of benefit for most patients.

Interventions That Could Be Used

The GDG uses 'consider' when confident that an intervention will do more good than harm for most patients, and be cost effective, but other options may be similarly cost effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

Cost Analysis

Relevant health economic evidence for recommendations can be found in the specific chapters of the full version of the guideline (see the "Availability of Companion Documents" field).

No studies were identified from published literature that assessed the cost-effectiveness of different monitoring frequencies and strategies. Thus, the Guideline Development Group (GDG) judged that an economic analysis would be useful to help inform recommendations on optimal monitoring. A cost-effectiveness analysis was not possible due to the absence of effectiveness data. Therefore a cost-sensitivity 'threshold' analysis was selected

as a feasible and informative approach. In this analysis the GDG present the number of complications and critical care episodes required for cost neutrality of various monitoring strategies versus 1) the cheapest strategy, 2) current practice. See Appendix M (see the "Availability of Companion Documents" field) for details of the analysis.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

Validation Process

This guidance is subject to a 6-week public consultation and feedback as part of the quality assurance and peer review of the document. All comments received from registered stakeholders are responded to in turn and posted on the National Institute for Health and Care Excellence (NICE) Web site.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of evidence supporting the recommendations is not specifically stated.

Type of Studies

For intervention reviews in this guideline, parallel randomised controlled trials (RCTs) were included because they are considered the most robust type of study design that can produce an unbiased estimate of the intervention effects. If the Guideline Development Group (GDG) believed RCT data were not appropriate or there was limited evidence from RCTs, well-conducted non-randomised studies were included.

Please refer to Appendix C (see the "Availability of Companion Documents" field) for full details on the study design of studies selected for each review question. For example, observational data was included in the clinical review for management of hyponatraemia as conducting an RCT with a time critical and potentially devastating condition could be considered unethical and is therefore unlikely.

See the 'Linking evidence to recommendations' section in each chapter of the full version of the guideline (see the "Availability of Companion Documents" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

The Guideline Development Group (GDG) agreed that in current practice there is variation in what is recorded and documented in a patient's chart and that providing guidance on what core information is required may lead to improvements in care.

See the "Trade-off between clinical benefits and harms" sections in the full version of the guideline (see the "Availability of Companion Documents" field) for additional discussion of benefits of specific interventions.

Potential Harms

- Errors in prescribing or administering intravenous (IV) fluids can result in inadequate or excessive provision, leading to hypovolaemia and poor organ perfusion, or hypervolaemia, oedema and heart failure. Failing to correct imbalances in electrolytes can lead to disturbances in intracellular or extracellular electrolyte balance, particularly in children and young people with reduced liver or kidney function. Failing to

deliver correct fluids can therefore have a significant impact on morbidity and mortality.

- The Guideline Development Group (GDG) felt that the use of body weight in children with a BMI above the 91st centile may overestimate fluid requirements. A more accurate prescription in this group of children may be made using body surface area to calculate fluid requirements.
- Resuscitation fluids containing potassium should be used cautiously in children at risk of hyperkalaemia as a rapid increase in potassium is cardiotoxic and has been associated with mortality.
- It was also noted that isotonic solutions may increase the risk of hypernatremia, but the GDG felt that, overall, hyponatraemia was considered to be a greater concern in the paediatric population.
- Hypotonic solutions can provide the daily sodium requirements in healthy patients, but may be associated with increased risk of adverse effects (including hyponatraemia) in ill patients.
- The GDG acknowledged that too much potassium can lead to the development of hyperkalaemia. The GDG agreed that using pre-made solutions reduces the risks associated with adding potassium manually and noted that it is standard practice to use pre-made solutions where they exist. Furthermore, there is a risk of adding potassium in a context such as acute kidney injury and therefore it is important to check electrolytes at the outset.

See the "Trade-off between clinical benefits and harms" sections in the full version of the guideline (see the "Availability of Companion Documents" field) for additional discussion of potential harms of specific interventions.

Contraindications

Contraindications

The Guideline Development Group (GDG) noted that, because of the risk of developing hyponatraemia, 0.18% sodium chloride solution is contraindicated in children except under expert medical supervision in paediatric specialist settings, such as renal, cardiac, liver, high dependency and intensive care units, as outlined in the National Patient Safety Agency Alert issued in 2007. The GDG excluded 0.18% sodium chloride solutions at the protocol stage for use as maintenance fluid in a non-specialist unit.

Qualifying Statements

Qualifying Statements

- Healthcare professionals are expected to take National Institute for Health and Care Excellence (NICE) clinical guidelines fully into account when exercising their clinical judgement. However, the guidance does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of each patient, in consultation with the patient and, where appropriate, their guardian or carer.
- Healthcare providers need to use clinical judgement, knowledge and expertise when deciding whether it is appropriate to apply guidelines. The recommendations cited here are a guide and may not be appropriate for use in all situations. The decision to adopt any of the recommendations cited here must be made by practitioners in light of individual patient circumstances, the wishes of the patient, clinical expertise and resources.
- The National Clinical Guideline Centre (NCGC) disclaims any responsibility for damages arising out of the use or non-use of this guideline and the literature used in support of this guideline.

Implementation of the Guideline

Description of Implementation Strategy

See the section "Intravenous fluid therapy in children and young people in hospital implementation: getting started" in the original guideline document. This section highlights 3 areas of the intravenous (IV) fluid therapy in children and young people guideline that could have a big impact on practice and improve quality of care. These areas were identified these with the help of stakeholders and guideline committee members. The section also gives information on resources to help with implementation.

Key Priorities for Implementation

The following recommendations have been identified as priorities for implementation.

Assessment and Monitoring

In term neonates, children and young people who are receiving IV fluids, assess and document the following:

- Actual or estimated daily body weight. Record the weight from the current day, the previous day, and the difference between the two. If an estimate was used, the actual weight should be measured as soon as clinically possible.
- Fluid input, output and balance over the previous 24 hours
- Any special instructions for prescribing, including relevant history
- An assessment of the fluid status
- The results of laboratory and point-of-care assessments, including:
    - Full blood count
    - Urea
    - Creatinine
    - Plasma electrolyte concentrations (including chloride, sodium and potassium)
    - Blood glucose
    - Urinary electrolyte concentrations
- Details of any ongoing losses
- Calculations of fluid needs for routine maintenance, replacement, redistribution and resuscitation
- The fluid and electrolyte prescription (in ml per hour), with clear signatures, dates and times
- Types and volumes of fluid input and output (urine, gastric and other), recorded hourly and with running totals
- 12-hourly fluid balance subtotals
- 24-hourly fluid balance totals
- 12-hourly reassessments of:
    - The fluid prescription
    - Current hydration status
    - Whether oral fluids can be started
    - Urine and other outputs

Fluid Resuscitation

If children and young people need IV fluid resuscitation, use glucose-free crystalloids[1] that contain sodium in the range 131–154 mmol/litre, with a bolus of 20 ml/kg over less than 10 minutes. Take into account pre-existing conditions (for example, cardiac disease or kidney disease), as smaller fluid volumes may be needed.

If term neonates need IV fluid resuscitation, use glucose-free crystalloids[1] that contain sodium in the range 131–154 mmol/litre, with a bolus of 10–20 ml/kg over less than 10 minutes.

Routine Maintenance

If children and young people need IV fluids for routine maintenance, initially use isotonic crystalloids[2] that contain sodium in the range 131–154 mmol/litre.

Measure plasma electrolyte concentrations and blood glucose when starting IV fluids for routine maintenance (except before most elective surgery), and at least every 24 hours thereafter.

If there is a risk of water retention associated with non-osmotic antidiuretic hormone (ADH) secretion, consider either:

- Restricting fluids to 50% to 80% of routine maintenance needs or
- Reducing fluids, calculated on the basis of insensible losses within the range 300–400 ml/m^2/24 hours plus urinary output

Replacement and Redistribution

Consider isotonic crystalloids[2] that contain sodium in the range 131–154 mmol/litre for redistribution.

Managing Hyponatraemia that Develops During Intravenous Fluid Therapy

If asymptomatic hyponatraemia develops in term neonates, children and young people, review the fluid status and take action as follows:

- If a child is prescribed a hypotonic fluid, change to an isotonic fluid (for example, 0.9% sodium chloride).
- Restrict maintenance IV fluids in children and young people who are hypervolaemic or at risk of hypervolaemia (for example, if there is a risk of increased ADH secretion) by either:
  - Restricting maintenance fluids to 50% to 80% of routine maintenance needs or
  - Reducing fluids, calculated on the basis of insensible losses within the range 300–400 ml/m^2/24 hours plus urinary output

Be aware that the following symptoms are associated with acute hyponatraemia during IV fluid therapy:

- Headache
- Nausea and vomiting
- Confusion and disorientation
- Irritability
- Lethargy
- Reduced consciousness
- Convulsions
- Coma
- Apnoea

Footnotes

[1]At the time of publication (December 2015), some glucose free-crystalloids did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

[2]At the time of publication (December 2015), some isotonic crystalloids with 5% to 10% glucose did not have a UK marketing authorisation for use in children and young people. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

Implementation Tools

Clinical Algorithm

Mobile Device Resources

Patient Resources

Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Staying Healthy

IOM Domain

Effectiveness

Patient-centeredness

Safety

Identifying Information and Availability

Bibliographic Source(s)

National Clinical Guideline Centre. Intravenous fluid therapy in children and young people in hospital. London (UK): National Institute for Health and Care Excellence (NICE); 2015 Dec 9. 33 p. (NICE guideline; no. 29).

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2015 Dec 9

Guideline Developer(s)

National Clinical Guideline Centre - National Government Agency [Non-U.S.]

Source(s) of Funding

The National Clinical Guideline Centre (NCGC) was commissioned by the National Institute for Health and Care Excellence (NICE) to undertake the work on this guideline.

Guideline Committee

Guideline Development Group (GDG)

Composition of Group That Authored the Guideline

Guideline Development Group (GDG) Members: Peter Crean, Consultant Paediatric Anaesthetist (*Chair*); Jan Dudley, Consultant Paediatric Nephrologist; Deborah Evans, Paediatric Nurse Practitioner; Andrew Fitzsimons, Consultant in Paediatric Emergency; Chris Gildersleve, Consultant Paediatric Anaesthetist; Lyda Jadresic, Consultant General Paediatrician with a special interest in paediatric nephrology; Ann Kelly, Advanced Paediatric Nurse Practitioner; Jayne Kranat, Patient/carer member; Aung Soe, Consultant Neonatologist; Stephanie Warne, Locum Consultant in Paediatric Surgery and Urology; Andrew Wignell, Specialist Clinical Pharmacist; Peter Wilson, Paediatric Intensive Care Consultant and Clinical Director

Financial Disclosures/Conflicts of Interest

At the start of the guideline development process all Guideline Development Group (GDG) members declared interests including consultancies,

fee-paid work, share-holdings, fellowships and support from the healthcare industry. At all subsequent GDG meetings, members declared arising conflicts of interest.

Members were either required to withdraw completely or for part of the discussion if their declared interest made it appropriate. The details of declared interests and the actions taken are shown in Appendix B (see the "Availability of Companion Documents" field).

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the National Institute for Health and Care Excellence (NICE) Web site . Also available for download in ePub or eBook formats from the NICE Web site .

Availability of Companion Documents

The following are available:

- Intravenous fluid therapy in children and young people in hospital. Full guideline. London (UK): National Institute for Health and Care Excellence; 2015 Dec. 141 p. (NICE guideline; no. 29). Available from the National Institute for Health and Care Excellence (NICE) Web site .
- Intravenous fluid therapy in children and young people in hospital. Appendices. London (UK): National Institute for Health and Care Excellence; 2015 Dec. (NICE guideline; no. 29). Available from the NICE Web site .
- Intravenous fluid therapy in children and young people in hospital. Algorithms. London (UK): National Institute for Health and Care Excellence; 2015 Dec. 6 p. (NICE guideline; no. 29). Available from the NICE Web site .
- Intravenous fluid therapy in children and young people in hospital. Baseline assessment tool. London (UK): National Institute for Health and Care Excellence; 2015 Dec. (NICE guideline; no. 29). Available from the NICE Web site .
- Intravenous fluid therapy in children and young people in hospital. Costing report. London (UK): National Institute for Health and Care Excellence; 2015 Dec. 4 p. (NICE guideline; no. 29). Available from the NICE Web site .
- Intravenous fluid therapy in children and young people in hospital. Diagram of ongoing losses for children and young people. London (UK): National Institute for Health and Care Excellence; 2015 Dec. 1 p. (NICE guideline; no. 29). Available from the NICE Web site .
- Intravenous fluid therapy in children and young people in hospital. Intravenous fluid types for children and young people. London (UK): National Institute for Health and Care Excellence; 2015 Dec. 1 p. (NICE guideline; no. 29). Available from the NICE Web site .
- The guidelines manual 2012. London (UK): National Institute for Health and Care Excellence (NICE); 2012 Nov. Available from the NICE Web site .

Patient Resources

The following is available:

- Intravenous fluid therapy in children and young people in hospital. Information for the public. London (UK): National Institute for Health and Care Excellence; 2015 Dec. 5 p. (NICE guideline; no. 29). Available from the National Institute for Health and Care Excellence (NICE) Web site . Also available for download in eBook and ePub formats from the NICE Web site .

Please note: This patient information is intended to provide health professionals with information to share with their patients to help them better understand their health and their diagnosed disorders. By providing access to this patient information, it is not the intention of NGC to provide specific medical advice for particular patients. Rather we urge patients and their representatives to review this material and then to consult with a

licensed health professional for evaluation of treatment options suitable for them as well as for diagnosis and answers to their personal medical questions. This patient information has been derived and prepared from a guideline for health care professionals included on NGC by the authors or publishers of that original guideline. The patient information is not reviewed by NGC to establish whether or not it accurately reflects the original guideline's content.

NGC Status

This NGC summary was completed by ECRI Institute on March 17, 2016.

The National Institute for Health and Care Excellence (NICE) has granted the National Guideline Clearinghouse (NGC) permission to include summaries of their clinical guidelines with the intention of disseminating and facilitating the implementation of that guidance. NICE has not yet verified this content to confirm that it accurately reflects that original NICE guidance and therefore no guarantees are given by NICE in this regard. All NICE clinical guidelines are prepared in relation to the National Health Service in England and Wales. NICE has not been involved in the development or adaptation of NICE guidance for use in any other country. The full versions of all NICE guidance can be found at www.nice.org.uk.

Copyright Statement

Disclaimer

NGC Disclaimer